PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Alternating Current Arc-Welding Process

We, UNION CARBIDE CORPORATION (formerly Union Carbide and Carbon Corporation), of 30 East 42nd Street, New York, State of New York, United States of America, a Corporation organised under the laws of the State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved alternating current arc welding process in which an arc shielding gas of argon and oxygen is employed around a fusible metal electrode and a high-frequency alternating potential is superimposed on the alternating welding current.

The process of the present invention provides an unexpected result, that is, the combination of oxy-argon as the arc shielding gas, alternating welding current, and superimposed high-frequency potential on the welding current, is effective to produce a spray type of metal transfer from the fusible metal electrode to the work at a lower alternating current level than that which was possible heretofore, along with stable operation and improved weld contour.

With only argon as the shielding gas in an arc welding process using superimposed high-frequency high-potential current on a 60 cycle or lower alternating current frequency, there was either no metal transfer from the fusible metal electrode during the straight polarity half-cycle of the welding alternating current below a certain relatively high current level, or such transfer was in the form of one large globule of molten metal during such half-cycle. With the addition of oxygen to the argon shielding gas, the metal transfer even below such current level is in the form of a series or spray of drops, similar to that existing in known direct current—reverse polarity arc welding using an inert shield of gas about the arc, thus improving the operation and the resulting weld bead.

The invention will be more particularly described with reference to the accompanying drawing:

A welding gun 10 is arranged above work 12 to be welded along a seam 14. Such gun 10 comprises a gas cup or nozzle 16 into which a regulated stream of oxy-argon gas is delivered through an arc-shielding gas inlet 18 from any suitable source of supply. Such stream of oxy-argon gas flows around a welding rod or wire 20 of fusible metal that passes axially through the nozzle, both gas and wire being discharged from the lower, open end of the nozzle. The work 12 and wire 20 are connected to a source 22 of high-frequency potential and to an alternating current welding source 24 by suitable circuit means including a rod-contact tube 26, and leads 28 and 30; a voltmeter 32, and an ammeter 34 being connected to such circuit to indicate the welding voltage and current, respectively. The wire or rod 20 is drawn from a reel 36 and fed to the gun 10 by a wire feed roll 38 that is driven by a rod feed motor 40.

In operation an arc A is struck between the lower end of the electrode wire 20 and the work 12 above the seam 14 and, as the adjacent work metal and lower end of the work and wire fuse due to the flow of welding current in such arc, the welding wire is fed toward such seam 14 and the gun 10 is moved in the direction of the seam, butt welding the work 12. Transfer of fused metal from the wire 20 to the work occurs in the form of a spray at a lower welding current level than is possible with an arc-gas shield of argon that is essentially free of oxygen.

Using alternating welding current from a conventional 60-cycle welding transformer and superimposing a high-frequency current on such welding current, a weld bead was made in a $\frac{3}{8}''$ mild steel plate from a $\frac{1}{16}''$ steel welding wire electrode surrounded by 5 per cent oxygen and 95 per cent argon arc shielding gas.

The addition of oxygen to argon lowers the current level at which the metal transfer

[*Price 3s. 6d.*]

progresses from a globule-like deposit to a spray of fine droplets. Also, the oxygen addition improves the general welding action and the quality of the weld.

The following table indicates welding conditions with a $\frac{1}{16}$ inch diameter welding wire composed of either CMS steel (hereinlater defined) or a stainless steel, Type 304 (hereinlater defined). The recorded welds were made on either Type 347 stainless steel (hereinlater defined) or on mild steel plate. A No. 4 ($\frac{1}{4}$ inch) elongated gas cup (nozzle) was employed and positioned approximately one quarter inch above the work. The gas was fed at a rate of between 60 to 70 cubic feet per hour. Welding (traverse) speed was 30 inches per minute.

In Welds Nos. 1 to 9 the mild steel rod was used for welding a mild steel plate, whereas in Welds Nos. 10 to 17 a stainless steel rod was used for welding a stainless steel plate.

Weld No.	Material	Shielding Gas	AC Amperes	Wire Speed (in./Minute)	Metal Transfer
1	Mild Steel	Argon	200	134	Slow drops
2	,,	,,	225	184	Transition
3	,,	,,	300	200	Rapid drop to spray
4	,,	,,	390	286	Spray
5	,,	Oxy-Argon*	150	88	Slow drop
6	,,	,,	200	124	Transition
7	,,	,,	225	184	Spray
8	,,	,,	315	210	Spray
9	,,	,,	500	500	Spray
10	Stainless	Argon	300	230	Spray
11	,,	,,	230	184	Transition
12	,,	,,	210	130	Slow drop
13	,,	,,	420	350	Spray
14	,,	Oxy-Argon*	208	130	Slow drop — transition
15	,,	,,	225	184	Spray
16	,,	,,	295	196	Spray
17	,,	,,	515	400	Spray

*5 per cent oxygen, 95 per cent argon.

In weld No. 6, a welding current density of 65,500 amperes per square inch was employed.

In weld No. 14 a welding current density of 68,300 amperes per square inch was employed.

A series of welds made to determine the transition currents at which the transfer of metal changed from drops to spray, indicated that lowest amperages at which the metal transfer altered to a spray were 225 and 200 when welding mild steel in argon and in the oxy-argon mixture specified, respectively, and 230 and 208 when welding stainless steel with an argon and in the specified oxy-argon gas shield, respectively.

Although the degree to which the transition current is lowered is not large, it indicates a definite reduction in the current required. More important, however, are the arc stability and the improved weld appearance which result from the present welding practice, and these characteristics are well defined.

As to the frequency range of the superimposed high-frequency, a low range of about 2 megacycles is estimated as workable, with an upper range of the order of 6 megacycles. Even with a 240 cycle alternating current welding power source, superimposed high-frequency was found necessary to stabilize and maintain the arc.

The percentage of oxygen that is mixed with argon according to the invention ranges from a very small amount, as one-tenth of one per cent oxygen in the case of highly refractory metals, such as welding titanium with a titanium electrode to upwards of 20 per cent to 50 per cent in the case where the speed of welding is more important than weld quality, such as welding rimmed steels with rimmed steel electrodes. Obviously helium might be substituted for or combined with argon without departing from the invention.

The following are the compositions of the various types of material referred to above:

WELDING RODS.

C.M.S.—C.M.S. refers to the alloys in this rod, viz., chromium, manganese, and silicon. Composition is medium carbon steel containing less than 2 per cent total of such alloys.

Type 304.—This is a specification set up by the American Iron and Steel Institute for an alloy of the following composition: C 0.08 max., Mn 2.00 max., Si 1.00 max., Cr 18.00—20.00, Ni 8.00—11.00, P 0.04 max., S 0.03 max.

Type 347.—Also American Iron and Steel Institute specification for an alloy of: C 0.08 max., Mn 2.00 max., Si 1.00 max., Cr 17.00—19.00, Ni 9.00—12.00, Cb 10×C minimum, P 0.04 max., S 0.03 max.

What we claim is:—

1. An improved alternating current arc welding process in which an arc shielding gas mixture of oxygen and argon or helium is disposed about a fusible metal electrode and a high-frequency alternating potential is superimposed on the welding current, characterized in that the gas mixture contains 0.1 per cent to 50 per cent oxygen, the balance being argon or helium, and a welding current is employed of such intensity as to deposit the electrode metal in the form of a spray.

2. A process as claimed in claim 1, in which the gas mixture contains 5 per cent oxygen and 95 per cent argon.

3. A process as claimed in claim 1 or 2, in which for welding mild steel current density of at least 65,500 amperes per square inch of electrode cross-section is employed.

4. A process as claimed in claim 1 or 2, in which for welding stainless steel a current density of at least 68,300 amperes per square inch of electrode cross-section is employed.

5. A gas-shielded alternating current arc welding process substantially as hereinbefore described with reference to the accompanying drawing.

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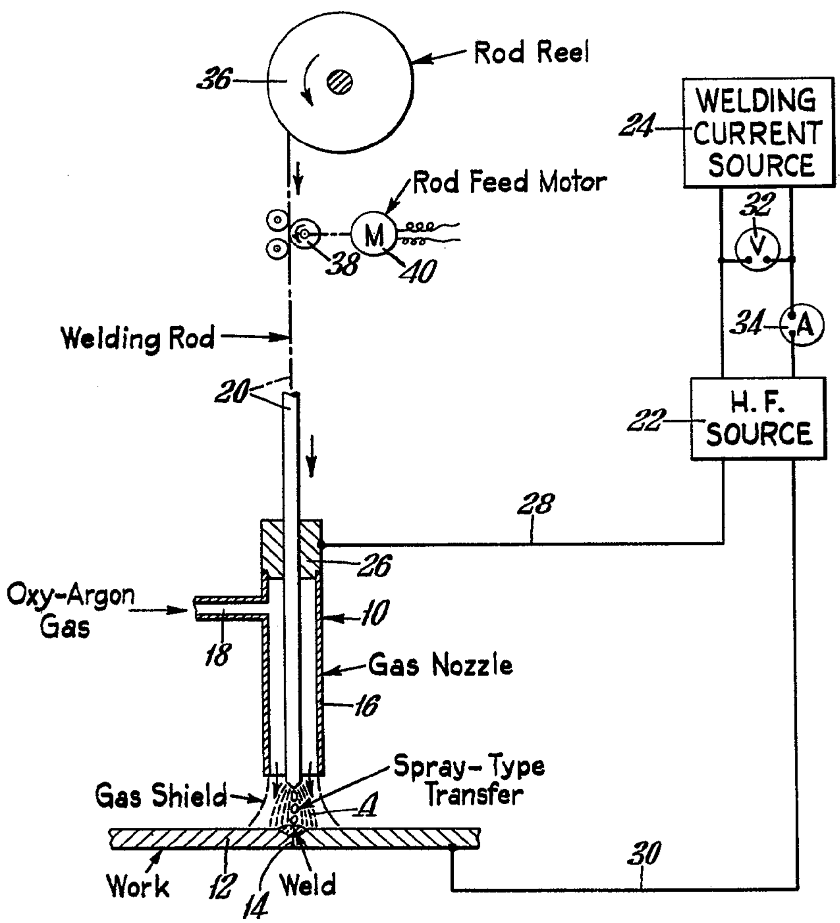
Rod Reel
36
WELDING CURRENT SOURCE
24
Rod Feed Motor
M
38
40
32
V
34
A
Welding Rod
20
H. F. SOURCE
22
28
26
Oxy-Argon Gas
10
18
Gas Nozzle
16
Spray-Type Transfer
Gas Shield
A
30
Work
12
14
Weld